Contents

Paras

General matters

Introduction 1 to 6

Limits and scope 7 to 12

Automatic presses

General 13 to 15

Automatically-fed individual presses 16 to 28

Automatically-fed multiple press systems 29 to 35

Manually-fed press converted to automatic operation 36 to 37

Foreword

In 1976 a subcommittee was appointed by the JSC to revise the Power Press Safety Code which was published in 1965, and at the same time to revise and bring up to date the information contained in the JSC reports and papers produced since 1965.

In 1979 the JSC published *Power Press Safety,* which consisted of six sections dealing with general matters, electrical equipment, arrestor brakes, clutches and brakes, guarding systems and safety in toolsetting and tool tryout. This was followed in 1981 by a section of the revised Power Press Safety Code dealing with *Press Tool Design, Part 1: Safety in Manipulation.* The JSC then asked the subcommittee to consider material feeding and component ejection, including safety in the use of tools.

This section is limited to devices which feed material directly into, or remove components directly out of, the tools. The preparation and handling of strip prior and subsequent to the press(es) is outside the scope of this document. The title of this document is *Safety in Material Feeding and Component Ejection Systems* which the JSC feels more adequately reflects the content than the originally proposed title of *Press Tool Design, Part 2.* The JSC supports the subcommittee's recommendations which should be of great assistance to all persons concerned with the operation of power presses and associated equipment.

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W Bedworth Wilkins and Mitchell Ltd

K Gill Amalgamated Union of Engineering Workers

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General matters

INTRODUCTION

1 The more efficient the guarding system, the less the risk of injury to hands during the loading or unloading of components. Nevertheless, there must be an element of danger, however remote, every time hands enter the trapping area. It follows that any system which reduces the need for access of hands is a contribution towards safety, provided that adequate safeguards are used to cover the occasions requiring access.

2 Methods of reducing the frequency of access to dangerous parts include:

(a) Automatic component unloading. (It should be noted that vertical ejection frees the component but does not remove it from the trapping area.)

(b) Automatic component loading and unloading. This covers:

(i) Automatic manipulation of single components through one or more sets of tools in one or more presses.

(ii) Strip or coil feeds taking material through tools which may perform one or more operations, the material being used to carry the components clear of the tools on the outgoing side where they are automatically separated from their carrier. Where these tool sets perform more than one operation, they are known as 'progression tools'.

3 Tool and die accidents during both production and toolsetting and try-out may be caused by a number of factors, e.g. repeat strokes, gravity fall, human error, uncovenanted strokes from rest. Whatever the reason, all such accidents occur when there is access to the tools, therefore any system which reduces such access contributes to increased safety.

4 Loading and unloading by hand normally requires access to the trapping area twice in every press cycle. Automatic unloading requires access (for loading) once per cycle. This reduces the risk but does not halve it because the risk of repeat strokes and gravity fall is still the same.

5 Automatic loading and unloading limits the frequency of access, and therefore the associated risk, to that required for setting the tools and feed mechanism, try-out and adjustment, initial monitoring of the components, the correction of mis-feeds (which may be frequent), lubrication, etc. The press output does not depend on the performance of the operator. It follows that there is time to ensure that the moving parts have come to rest before access is possible. The danger from a repeat stroke can therefore be effectively reduced by the provision of sequential guard opening. If the movement of the press flywheel is disregarded, the sequence effect need only be long enough to ensure that the slide has come to rest, preferably at its normal stopping position. Provided the guard incorporates an interlocking system which effectively prevents engagement of the clutch unless the guard is closed, the principal remaining danger is uncovenated movement from rest. Records over many years have shown that such movement is a remote risk which can, however, be reduced during toolsetting procedures on presses upon which the crankshaft can be manually rotated, if the guard sequence mechanism incorporates equipment to hold the guard closed until flywheel movement has ceased.

6 Consideration will now be given to the wide range of equipment and methods to provide automatic unloading and loading.

Note *Automatic unloading is very much the easier process, the reason being that the position of the component at the end of the unloading process is not critical, whereas in loading, the position of the component in the tool is critical in position, and frequently in orientation.*

LIMITS AND SCOPE

7 This report gives information on the safe working of presses and their tools when material feeding and component ejection devices are being used. The report also mentions the devices themselves but is limited to devices for feeding material and components directly into, and for removing finished work and scrap directly out of a press or a number of presses. The preparation and handling of coil and strip prior and subsequent to the press(es), although closely associated, is considered to be an area outside the scope of this report.

8 Separate consideration is given to single presses and multiple press systems because of the different requirements of the two systems.

9 Since the publication of the Sixth Report of the Joint Standing Committee on Safety in the Use of Power Presses in 1968, many of the feeding and handling devices described therein have been found to have great advantages in increasing production to the extent that many such arrangements are now recognised as possibly the most efficient means of production. Throughout the whole field of automatic feeding and ejection the operator safety level is much higher than with equivalent hand fed work but it is essential to ensure that access to the additional trapping areas

introduced by the provision of component or material handling equipment, is prevented when the system is in operation or otherwise in a potentially dangerous situation.

10 The opportunities for increased use of new and more sophisticated programmable electronic systems (p.e.s.) should increase the usefulness of feeding and handling devices in the press shop. The use of such devices may increase productivity and also have benefits in increasing safety in press operations. However, great care should be taken in their use since they may introduce new hazards. These hazards are much increased if the p.e.s. is used to initiate the press stroke.

11 Two of the simplest methods of avoiding the insertion of fingers into the trapping area are:

(a) manual feeding of strip through a fixed guard and

(b) the use of gravity feed chutes for loading prepared blanks. (Fig 1). Standard presses designed for hand feeding may be converted to automatic presses by the addition of power feeding and handling devices. Where such a conversion is made, care must be taken to ensure that both the press and the guards are suitable for the new duty. (Paras 36 and 37). On the other hand, many presses are now designed as complete automatic production

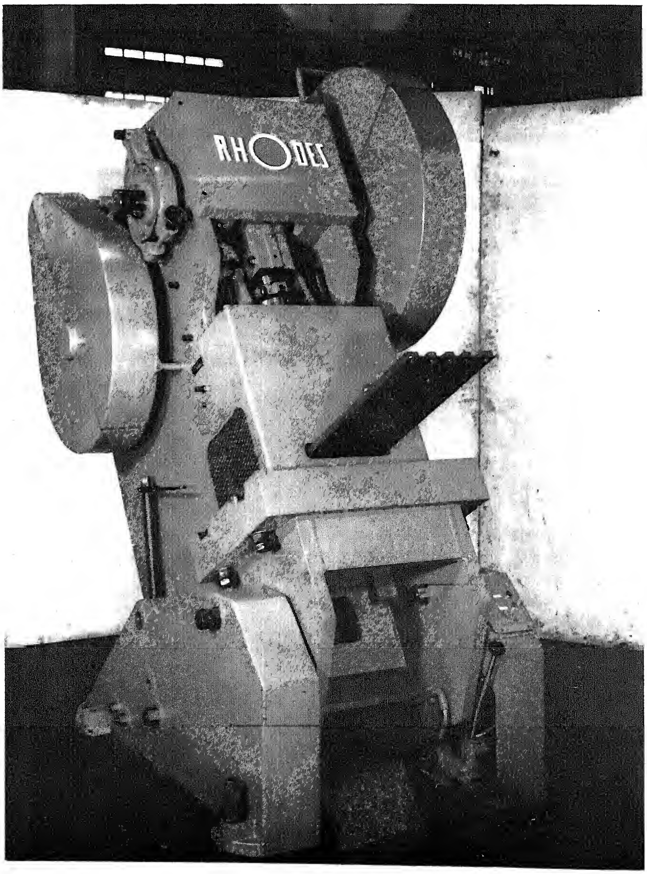

Fig 1 Slide feed chute for loading prepared blanks. (para 11)

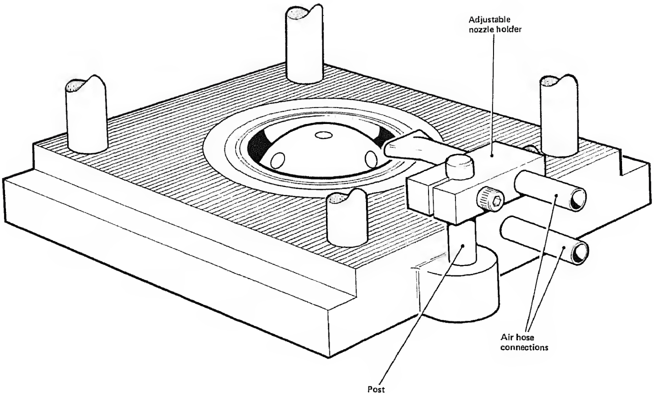

Fig 2 Air ejector. The application of air blast to press tools for elevation and discharge of the component from the working area. (para 12(b)) The air nozzles should be of the 'quiet' type, should be carefully selected and should be properly fitted so that unnecessarily high noise levels are not produced.

units including material feeding, component handling, ejection and scrap disposal. Sections are included in this report which deal with safety aspects of this type of automatic press unit and with units which comprise two or more linked presses.

12 Many of the types of material feeding and component handling devices now in current use may have advantages in both safety and in the efficiency of production. The devices in most general use may be classified as follows:

(a) *Feeding devices*

(i) Manual devices — Strip feeding,
Gravity chute feeding,
Slide feeding.

(ii) Powered devices for strip and coil —
Roll feeds (single or double)
Bow feeds,
Gripper feeds.

(iii) Powered devices for components —
Magazine feeds,
Bowl feeds,
Dial feeds,
Blank feeds,
Mechanical-hand feeds,
Transfer feeds,
Robotic feeds.

(b) *Component removal*
Mechanical extractor or kicker
Conveyor,
Air ejector (Fig 2)
Mechanical-hand (or other external mechanical devices),
Gravity,
Robotic extractor.

(c) *Scrap disposal*
Conveyor,
Cropping (both within the tool and external),
Gravity.

Automatic presses

General

13 For the purpose of safety presses may be said to be operating automatically if the workpieces are loaded and unloaded by non-manual means so that the operator is not required to place his hands in the tool space area.

14 There are important differences, as enumerated below, between the safety requirements of operator fed presses, single automatic presses and multiple automatic press systems.

(a) Operator fed presses where hands are inserted in the trapping area prior to each press stroke require stringent guarding systems, (described in *Power Press Safety* — 'Guarding Systems') to ensure that hands etc are clear of the trapping area before the dangerous part of each stroke takes place.

(b) Automatically fed individual presses should not require frequent access to the tools and the guarding of the tool area may be simplified. The addition of feeding and unloading equipment, however, may constitute additional hazards which must also be guarded.

(c) Automatically fed multiple press systems require the same protection as individual automatic presses with additional guards to prevent access to dangerous areas which may be created between or adjacent to the presses constituting the line.

15 Most automatic presses are operated by friction clutches with electrical controls which can be readily interlocked with guarding systems. Where a full revolution mechanical clutch press is used for automatic work, electrical interlocking is not appropriate in most cases. In such cases, the guarding standards for operator fed presses should be applied.

Automatically-fed individual presses

16 The tool space guarding is dealt with in an earlier section of *Power Press Safety* ('Guarding Systems', Para 18a (i) (ii) (iii)). This recommendation provides adequate guarding of the high risk tool space area on the assumption that access will only be required for tool setting and fault clearance. The

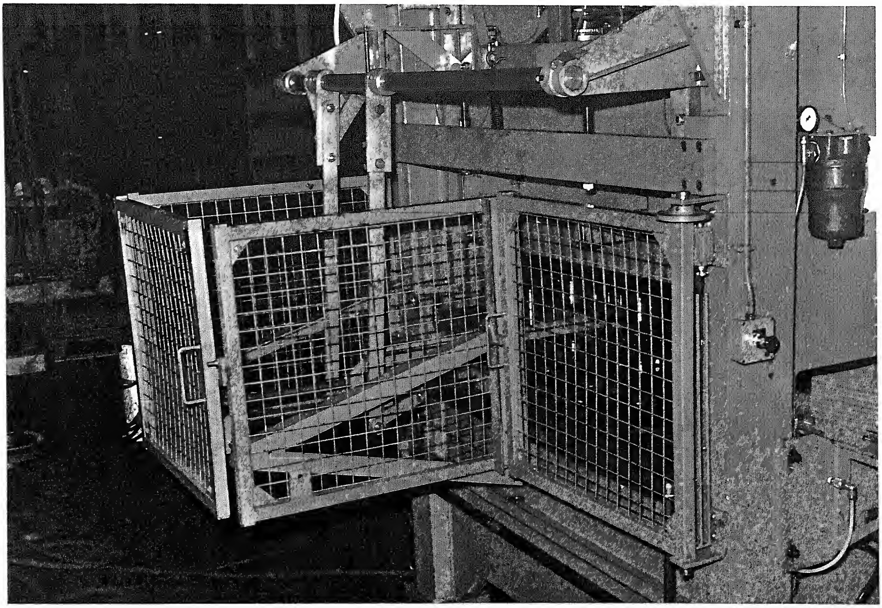

Fig 3 Mechanical unloading mechanism consisting of a sliding tray which is positively driven from the press slide. The tray catches components as they fall from the top tool at the end of the press stroke, carries them out of the press and tips them into a stillage under the guard. The unloading mechanism is fitted with fixed and interlocking guards. (para 16).

guarding standard requires that the press cannot be started until the guard is closed and that the guard cannot be opened until the press has stopped.

17 Additional enclosure is required for all dangerous moving parts of ancillary equipment e.g. feed mechanisms, both rotary and reciprocating unloading mechanisms and scrap shears. (Fig 3). This equipment may be mechanically driven from the press or independently powered and may cause hazards with varying degrees of risk.

18 A wide range of frequency of access may be required. For this reason varying standards of guarding may be necessary to suit the circumstances. These and their applications are described below:

(a) Electrical interlocking of the screen, door or shutter to prevent starting until the guard is closed, plus a guard control which prevents opening the guard until the press has stopped (as described in *Power Press Safety* ('Guarding Systems', para 18(a) (i) (iii)). Figs 4 and 5).

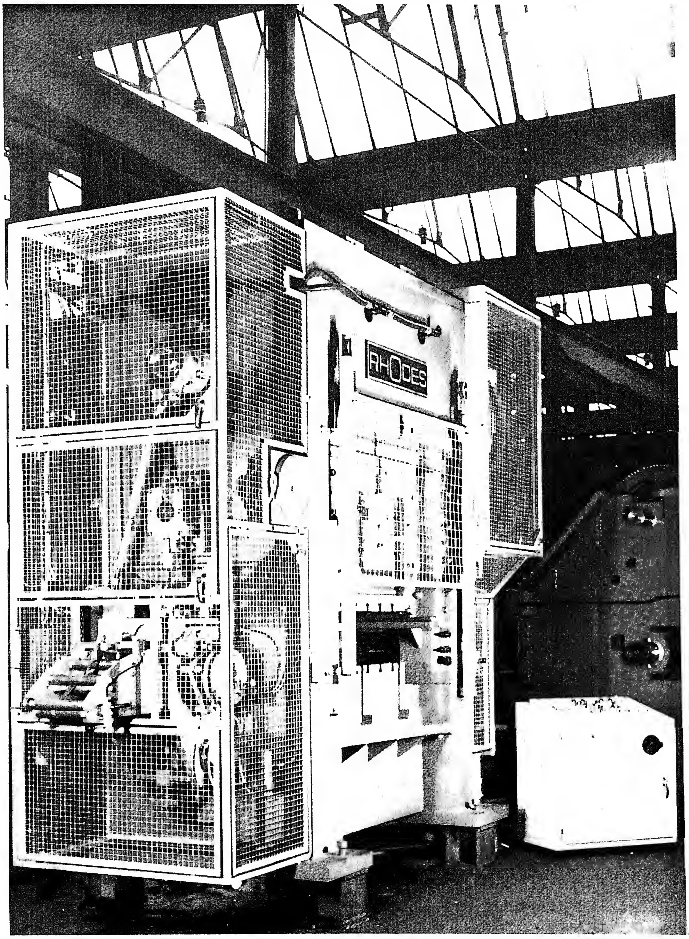

Fig 4 Automatically fed individual press with fixed guards and electrically interlocked gates around the feeding and ejection devices. The tool area guarding is electrically interlocked with an air operated 'hold closed' mechanism while the press clutch is engaged. The guard is shown in the open position. (para 18)

(b) Electrical interlocking only.

(c) Provision of a lockable gate, door or shutter which can only be opened by a removable key or tool.

(d) Fixed enclosures which are bolted in position and can only be opened or removed by use of a tool.

19 The (a) system should be used in all high risk areas where access may be required for fault clearing, maintenance and setting and where an uncovenanted stroke could cause severe injury. A scrap shear is in this category.

20 The screen door or shutter should be interlocked with the press clutch control system. The stopping time of the press, after clutch engagement, is normally small enough to ensure that the moving parts have come to rest before access to the trapping area through a guard is possible.

21 Where interlocking is by switches operated by a moving guard, the installation should comprise two switches wired in series for each guard. At least one of the switches should operate in the positive mode, ie the movement from 'off' (open) to 'on' (closed) is generated within the switch, while the movement from 'on' to 'off' is applied externally and is positive. (One advantage of this mode is that the switch can only be wedged in the 'off' position).

22 Where interlocking is by the use of a trapped key system, a single switch only is required for each guard.

23 The (b) system may be used to enclose rotating or reciprocating mechanisms to which access is foreseeably required only for maintenance or setting purposes. Such areas may include rotating or reciprocating feed drives and associated adjustment facilities.

24 The (c) system may be used to enclose rotating or reciprocating mechanisms to which access is foreseeably required only for maintenance purposes by specialist personnel eg the adjustment of auxilliary drive belt tension.

25 The (d) system may be used as an alternative to the (c) system where maintenance access is very infrequent and where provision of a

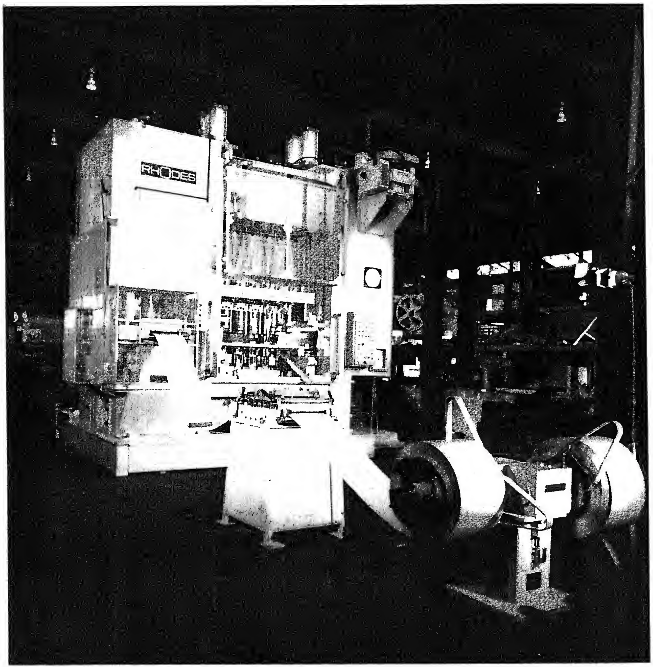

Fig 5 Coil feeding equipment on a transfer feed press with fixed and interlocking guards. The tool area guarding is electrically interlocked with an air-operated 'hold closed' mechanism while the clutch is engaged. The guard is shown in the open position. Guarding has been removed from the coil feeding/handling equipment. (para 18)

removable panel or enclosure is a practical alternative. Removable panels or enclosures should not be used where foreseeable access may be frequent, e.g. at every tool change, otherwise the guard may not be replaced in position.

26 If it is desirable to permit access only to the toolsetter or other authorised person, the (a) and (b) systems should also be fitted with lockable gates as described in (c).

27 Where electrical interlocks only are used the press should stop if the guard is opened during the working cycle. Under normal circumstances the guard should not be used as a means of stopping the press. If the stop occurs when the tools are in contact the press may jam at the bottom of stroke involving subsequent difficulties and possibly hazards of de-jamming and freeing the material or component. This situation may be prevented by arranging the control circuit so that the press does not stop at or near the bottom of the stroke. Where applicable a suitable independent stop switch should be provided to bring the machine to rest at its 'end of cycle' position. In such cases and in all other cases where opening of the guard does not initiate an immediate stop it is desirable that a suitable time delay feature be provided to ensure that access through the guard cannot be gained until all dangerous motion has ceased.

28 In some cases an individual automatic press may require an interlocked guard of size and location such that there is standing room inside the guarded area (Fig 6) but as this situation is more likely to occur on multiple automatic press systems it will be dealt with in the next section.

Automatically-fed multiple press systems

General

29 Such systems comprise two or more presses linked by automatic component loading and unloading equipment and in some cases including strip feeding and scrap handling devices as used on individual automatic presses. The motion of the presses is always electrically controlled.

30 The tools and any other dangerous parts require guarding to the same standards as individual automatic presses but with a multiple press system additional trapping areas are created. These areas include loading and unloading equipment, inter-press conveyors or transfer beams and any other dangerous moving parts between the individual presses, (Fig 7).

31 Guards should be provided which exclude personnel from all such trapping areas within the system. An effective guard is vertical fencing which should be sufficiently high to prevent

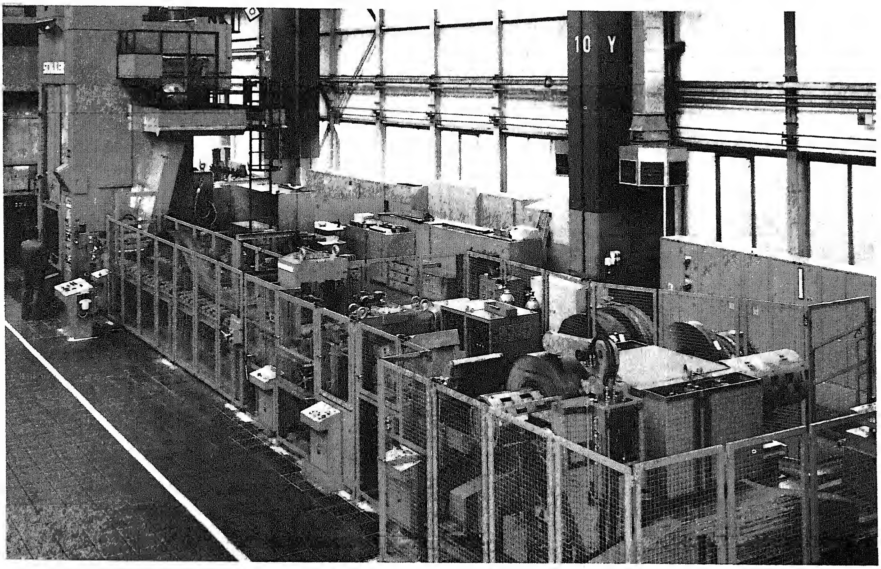

Fig 6 Interlocked enclosure guarding around the feeding devices on an automatically fed individual press. (para 28)

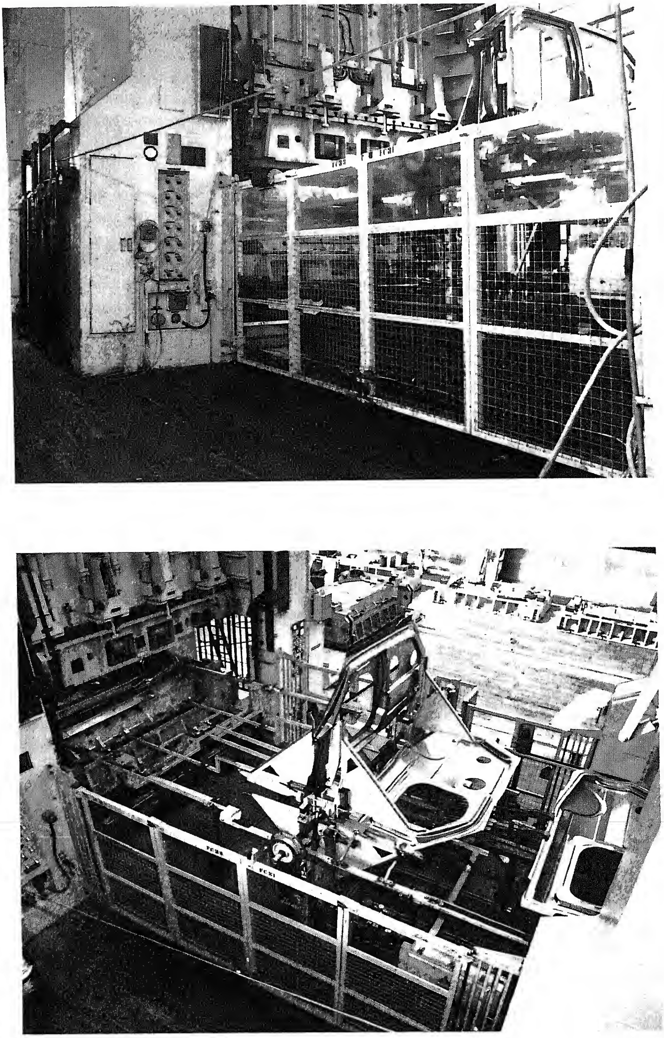

Fig 7(a), (b) and (c) Guarding around an automatically fed multiple press system. (para 30) Fig (a) shows the interlocked fencing, (b) (below) shows the 'turn over' mechanism between two presses, and (c) (opposite) is a general view of the press line showing the perimeter guarding and the sliding bolsters.

persons reaching any dangerous part or from easily getting over the fencing, 1400 mm is considered to be the minimum height to prevent the latter. The guarding may have a clearance of not more than 150 mm above floor level. Access inside the guard can be provided through an interlocked screen or door which may be of the hinged or sliding type. The type of interlocking required may be assessed by reference to paras 16 to 28.

Spring loaded doors and trapped key interlocking systems

32 Where moving guards operate limit switches and there is space inside the guarded area which can accommodate personnel, there is a risk that the guard will close, thus re-making the switches with the personnel in the danger area. This risk can be much reduced by spring loading or equivalent means which prevent the guard closing except by deliberate effort which includes the manual application of a catch from outside the guard to hold it closed. The closing of the door should not of itself initiate movement ie a reset facility should be provided. An alternative method of dealing with this risk is to use a trapped key interlocking system. This system ensures that the guard cannot be opened unless the dangerous moving parts have been isolated by removal of a key from the associated interlocking switch, this key being essential to unlock the guard. When the guard is unlocked, the key is trapped in the lock and can only be removed to actuate the switch after the guard has been closed and locked. The risk of defeating the system by locking a door closed with personnel inside, can be reduced by providing an additional key at each guard for retention by the person going inside the guard. This prevents the guard key from being returned to the interlocking switch without the knowledge (and co-operation) of the person inside the guard.

Note: *The availability of any duplicate keys should be strictly controlled so as to ensure that only one key is available for each door lock at any one time.*

33 Care is needed in establishing the area of control of each interlock. This should ensure that all dangerous moving parts which are accessible through any guard are at rest before access is possible. Where necessary effective time delay devices should be fitted.

34 Alternative means of preventing persons being at risk if guards are inadvertently closed behind them may also be used. Such means can include (a) the provision of lock-on stop buttons to prevent dangerous motions. These are to be operated on entry to the risk area and released on leaving, (b) sensing devices which when sensing the presence of a person inside a danger area prevent operation of the machine, e.g. pressure-sensitive mats in suitable locations.

Production considerations

35 The loss caused by hold-ups of production on presses can be very high. Consider an assembly plant which requires pressed components. Modern methods aim to keep buffer stocks small. If a hold-up is long enough to exhaust such a buffer stock, the cost of the hold-up becomes enormous. Good safety practice, therefore, should strive to eliminate hold-ups. Two examples of good practice are:

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(a) Provision of an overriding control to the press clutch to prevent stopping and possible jamming on bottom dead centre following the operation of an interlocking switch. (See para 27.)

(b) Where trapped key interlocking systems are used, the risk of the primary key being accidentally removed or lost can be eliminated by tethering the key (e.g. on a chain) so that it can reach both the lock and the switch with which it is associated. This requires a switch reasonably adjacent to each lock, with some increase in the cost of the installation, but having the additional advantage of reducing the distance the key has to be moved.

Manually-fed press converted to automatic operation

36 Where a press is converted from manual to automatic operation by the addition of material and component handling equipment, care must be taken to ensure that both the press and guards are suitable for the new duty. Where the feeding system requires the press to work on single-stroke operation it is essential to ensure that the press

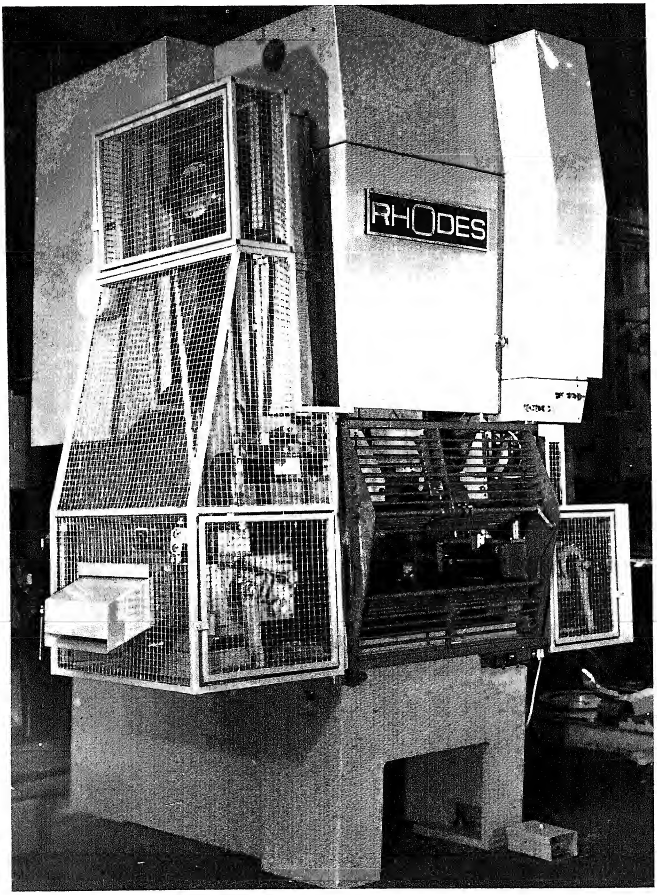

Fig 8 Manually fed press converted to automatic operation with fixed guards around the feeding and ejection devices. The operator's guard can be retained in the closed position during automatic operation and it is possible to revert to manual feeding when necessary (as illustrated). (para 37)

clutch and brake are adequate for the frequency of stroking demanded. In many cases this may be greatly in excess of the manual feeding rate for which they were designed and if so, clutch or brake failure may result. In all such cases competent advice should be sought, preferably from the manufacturer, and his recommendations complied with.

37 If the converted press is already fitted with an operator's guard, this may be suitable for automatic operation provided that it can be retained in the safe (closed) position. (Fig 8).

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